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Effects of tree species biodiversity on soil C and N pools: a regional case study in northern Italy

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Introduction

Site conditions are known to affect local resource availability, therefore being an important driver of plant species diversity. On the other hand, tree species are known to affect soils through addition of above- and belowground litter, absorbing nutrients and water and by association with various soil organisms. However it is still not well known whether species-diverse forests provide higher soil carbon stocks and nutrient status (Dawud *et al*., 2016).

Objectives

Investigate the existence of relationships between tree species diversity and soil C and N stocks using the data collected with a Regional Forest Carbon Inventory in Northern Italy.

Materials & Methods

Soil and aboveground vegetation data were collected within the Regional Forest Carbon Inventory of the Trento Province (InFoCarb, Rodeghiero *et al*., 2010), on 150 plots of 600 m^2 surface. Forest floor and mineral soil were sampled from three mini-pits inside each plot. Tree biodiversity was quantified both as Species Richness (Margalef Diversity Index, Gamito, 2010) based on the number of individuals belonging to different tree species and by using the proportions of basal area for each constituent species (Simpson's Index and Shannon-Wiener index). A subsample of 71 conifer-dominated plots (basal area >40%; Fig.1) growing on the same soil type (Dystric Cambisols, FAO_{WRB}, 1998) and having natural origin were selected. A forward stepwise multiple regression model was adopted to assess significant effects of biodiversity, site and stand variables on soil C and N content.

Dependent variables	Independent variables	b	*P* value
C:N (0-10 cm)	Intercept	30.530	<0.001
R^2=0.47	Rock type	0.018	<0.001
	Species richness	-1.053	<0.001
	P:T ratio	-0.028	0.035
	Age Max	0.027	0.005
	Margalef index	-0.029	0.123
	Slope	-0.026	0.147
	Elevation	-0.003	0.265
C:N (10-30 cm)	Intercept	9.813	0.408
R^2=0.48	Precipitation	-0.013	<0.001
	Species richness	-1.327	<0.001
	T° Excursion	2.021	0.002
	Wood increment (%)	-1.374	0.028
	Simpson concentration	-10.393	0.002
	Shannon Entropy	17.107	0.006
	Age Max	0.015	0.178

Table 1 – Results of the forward stepwise multiple regression: effects of different variables on mineral soil C:N ratio.

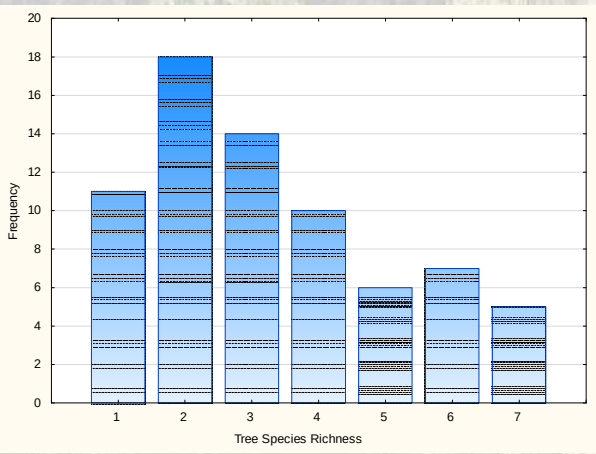

Fig. 1 – Frequency distribution of the number of species in the investigated plots. Monocultures are dominated by Norway Spruce (*Picea abies* Karst).

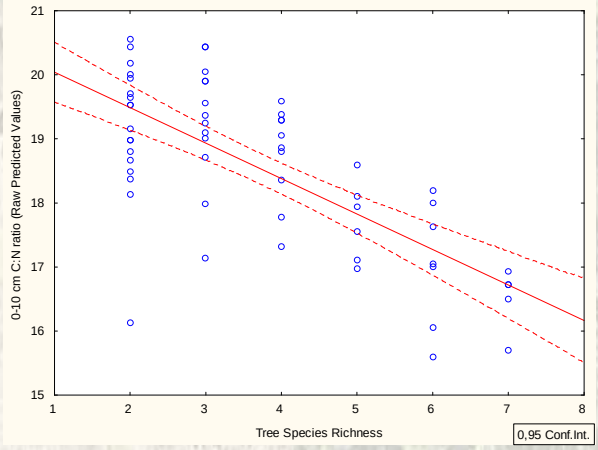

Fig. 2 – Tree Species Richness vs. 0-10 cm C:N ratio raw predicted values obtained from the multiple regression model.

Results

When including in the regression model only the biodiversity indexes, Species Richness resulted to be significantly ($p<0.05$) and negatively related to soil CN ratio of the mineral layers (both 0-10 cm and 10-30 cm depth; Fig.2) although explaining a very small proportion of the variance (0-10 cm = 12% and 10-30 cm = 7%). No other significant effects were detected. With the inclusion of 17 independent variables, most statistically significant results were evident for the mineral layers (Table 1).

Conclusions

Tree species diversity was selected as one of the main drivers of soil C dynamics in the regression models after some major soil forming factors *i.e.* rock type and precipitation. The effect of tree species richness on soil C and N pools appeared to be more pronounced for the mineral soil layers than for the superficial layers. The soil carbon stored in deep layers have a higher turnover time, thus reflecting more than the superficial layers the long period effects of both aboveground and belowground vegetation inputs. Similar results are reported by Dawud et al. (2016). In this preliminary study, species diversity seemed to affect more the soil C:N ratio than the single C and N stocks. On the other hand the C:N ratio reflects SOM decomposition and thus sol C dynamics. Further data elaboration will be performed to get more insights on the bio-link between aboveground vegetation and soil properties

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